Competition between the Jeans and Convective Instabilities in a Self-Gravitating Magnetized Gas Disk

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In order to investigate how the Jeans instability competes with the convective instability in a self-gravitating magnetized gas disk, we have applied adiabatic perturbations to the disk in an isothermal equilibrium, and derived dispersion relations and eigenfunctions under various conditions.

In the disk, three kinds of instabilities operate: a Parker-type driven by self-gravity, the usual Jeans, and the convective instabilities. For the perturbations in the direction of magnetic fields, two peaks appear in the dispersion relation: one at smaller wavenumber is due to the Jeans instability, and the other at larger wavenumber due to the convection originated by the Parker-type instability. For the perturbations in the horizontal direction perpendicular to the fields, the convection dominates the system at large wavenumbers, while the Jeans instability does the same at small wavenumbers. The growth rate of the convective instability attains its maximum value at largest wavenumber, but it may or may not be higher than the peak growth rate of the Jeans instability depending on the adiabatic index and ratio of the magnetic to the gas pressure, as well as the half thickness of the disk. For thick disks, a cooperative action of the Jeans and Parker instabilities can have chances to override the convective instability. For thin disks, the Jeans mode always overrides the convection mode, and results in structures parallel to the magnetic fields.